National Institute of Environmental Health Sciences

Ocean climate change, phytoplankton community responses, and harmful algal blooms: A formidable predictive challenge

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Abstract:

Prediction of the impact of global climate change on marine HABs is fraught with difficulties. However, we can learn important lessons from the fossil record of dinoflagellate cysts; long-term monitoring programs, such as the Continuous Plankton Recorder surveys; and short-term phytoplankton community responses to El Niño Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO) episodes. Increasing temperature, enhanced surface stratification, alteration of ocean currents, intensification or weakening of local nutrient upwelling, stimulation of photosynthesis by elevated CO2, reduced calcification through ocean acidification ("the other CO2 problem"), and heavy precipitation and storm events causing changes in land runoff and micronutrient availability may all produce contradictory species- or even strain-specific responses. Complex factor interactions exist, and simulated ecophysiological laboratory experiments rarely allow for sufficient acclimation and rarely take into account physiological plasticity and genetic strain diversity. We can expect: (i) range expansion of warm-water species at the expense of cold-water species, which are driven poleward; (ii) species-specific changes in the abundance and seasonal window of growth of HAB taxa; (iii) earlier timing of peak production of some phytoplankton; and (iv) secondary effects for marine food webs, notably when individual zooplankton and fish grazers are differentially impacted ("match-mismatch") by climate change. Some species of harmful algae (e.g., toxic dinoflagellates benefitting from land runoff and/or water column stratification, tropical benthic dinoflagellates responding to increased water temperatures and coral reef disturbance) may become more successful, while others may diminish in areas currently impacted. Our limited understanding of marine ecosystem responses to multifactorial physicochemical climate drivers as well as our poor knowledge of the potential of marine microalgae to adapt genetically and phenotypically to the unprecedented pace of current climate change are emphasized. The greatest problems for human society will be caused by being unprepared for significant range expansions or the increase of algal biotoxin problems in currently poorly monitored areas, thus calling for increased vigilance in seafood-biotoxin and HAB monitoring programs. Changes in phytoplankton communities provide a sensitive early warning for climate-driven perturbations to marine ecosystems.

Source: Ask your librarian to help locate this item.

Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Extreme Weather Event, Food/Water Quality, Food/Water Quality, Precipitation, Sea Level Rise, Solar Radiation, Temperature, Other Exposure

Extreme Weather Event: Flooding, Hurricanes/Cyclones

Food/Water Quality: Biotoxin/Algal Bloom, Biotoxin/Algal Bloom, Other Water Quality Issue

Water Quality (other): Ocean acidification; Nutrients; Water temperature; Stratification

Temperature: Fluctuations

Other Exposure: Ocean currents

Geographic Feature: ☒

resource focuses on specific type of geography

Freshwater, Ocean/Coastal

Geographic Location: ☒

resource focuses on specific location

Global or Unspecified

Health Impact: ☒

specification of health effect or disease related to climate change exposure

Infectious Disease, Morbidity/Mortality, Neurological Effect

Infectious Disease: Foodborne/Waterborne Disease

Foodborne/Waterborne Disease (other): Gastrointestinal illness

Mitigation/Adaptation: ☒

mitigation or adaptation strategy is a focus of resource

Adaptation

Resource Type: ☒

format or standard characteristic of resource

Review

Timescale: ☒

time period studied

Time Scale Unspecified